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(54) Actuation means for an electronically controlled brake system of a motor vehicle

(57) An actuation means for an electronically controlled brake system of a motor vehicle, comprises a cylinder/piston means (10) operatively connected to a brake pedal (28) to feed hydraulic fluid into a brake system of the motor vehicle, a spring means (40) resiliently biasing the brake pedal (28) against an actuation direction (P)of the brake pedal (28), characterized by at least two sensor means (36, 42, 54, 56) for sensing dimensions related to a normal actuation of the brake pedal (28), said at least two sensor means (36, 42, 54, 56) being adapted to output sensor signals to an electronic control unit (ECU) for processing said sensed dimensions.

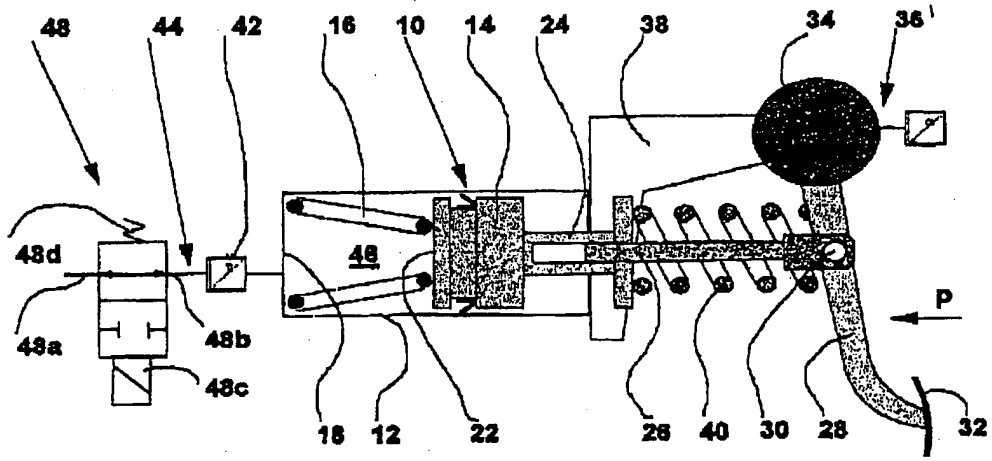

Fig. 1

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Description

The present invention relates to an actuation means for an electronically controlled brake system of a motor vehicle. More precisely, the present invention relates to an actuation means for an electronically controlled brake system of a motor vehicle, comprising a cylinder/piston means operatively connected to a brake pedal to feed hydraulic fluid into a brake system of the motor vehicle, and a spring means resiliently biasing the brake pedal against an actuation direction of the brake pedal.

Brake cylinder means of differing designs are well known in the art. However, in so-called "brake by wire" brake systems, there are various problems with respect to suitable brake pedal means. In brake by wire systems the actuation of the brake pedal by a driver is sensed electronically by a sensor means coupled to the brake pedal. The signal derived from said sensor means is fed into an electronic control unit (ECU). In said electronic control unit the input signal is processed and an electronical output signal is provided to activate an electromechanical actuator which operates on brake pads at the wheels.

For safety reasons it is necessary to provide a path parallel to the brake by wire path described above. This parallel path is from the brake pedal means via a fluid brake cylinder to an hydraulic actuator operating the brake pads at the wheels in case the brake by wire path fails.

Such a system is called a "push-through-system". During a normal actuation, where the brake by wire path is operable, the hydraulic piston is inoperative. During an emergency actuation where the brake by wire path is inoperative, the signal from the sensor means is ignored or not present, the brake pedal is "pushing-through" the brake cylinder and feeds hydraulic fluid to the brake pads at the vehicle wheels in order to decelerate the vehicle.

One problem with respect to the above described actuation means is the risk of a broken spring means or a spring means stuck in its guiding should such a guiding be present. The spring means is responsible for the "pedal feeling" for a driver. If the spring means is inoperative, the brake pedal can not be used in a satisfactory manner. Moreover, during an absence of a properly working spring means the brake pedal might be actuated once but will not be returned to its rest position. Therefore, it would be impossible to safely drive the motor vehicle.

From the above it becomes appearant that it is important to be able to check the functionality and operability of the spring means.

One object underlying the present invention is to provide an actuation means for an electronically controlled brake system with high reliability.

To solve this problem, the actuation means according to the present invention is characterized by at least two sensor means for sensing dimensions related to an actuation of the brake pedal, said at least two sensor means being adapted to output sensor signals to an electronic control unit (ECU) for processing said sensed dimensions.

The provision of at least two sensor means allows for sensing physical dimensions and values that are suitable for recognizing any malfunction of the actuation means and especially of the spring means resiliently biasing the brake pedal against an actuation direction of the brake pedal.

To this end, the two sensor means provide signals suitable for verifying the consistency of the two sensed dimensions.

Presently preferred embodiments and enhancements thereof are claimed in dependent claims 2 to 12 and are explained hereinafter.

In one preferred embodiment, one of said sensor means is adapted for sensing a rotational angle resulting from a rotational movement of the brake pedal about a support means of the brake pedal. Such a sensor can be attached easily to the fulcrum of the brake pedal. Moreover, such rotational sensors are cost effective and very reliable. However, the rotational movement of the brake pedal about its support means is usually an angle not exceeding approximately 60°. Wear of the support means can result in measuring errors.

In another embodiment, one of said sensor means is adapted for sensing a distance between a predetermined location of the brake pedal and a location being in a fixed relation to the support means of the brake pedal. Due to the fact that the path travelled by the brake pedal from its rest position to its fully actuated position is relatively long, a good resolution of the measured travel path can be obtained. Wear or play of the brake pedal means and its support means do not have a great influence.

In an another embodiment, one of said sensor means is adapted for sensing the distance resulting from a movement of the piston relative to the cylinder of the cylinder/piston means. Again, the long distance between the rest position and the fully actuated position of the brake pedal means provides for a high resolution of the sensed travel path. The piston of the cylinder/piston means may be build up of more than one part. In such embodiments it is important that a movement of the part carrying out a movement relative to the cylinder during a normal actuation of the brake pedal is sensed.

In still another embodiment one of said sensor means is adapted for sensing a force representative for an actuation force acting on the brake pedal. Such a sensor means allows for a very accurate and direct sensing of the actuation of the brake pedal means by a driver.

Preferably, one of said sensor means is adapted for sensing a pressure representative for a pressure in a (hydraulic) chamber of the cylinder/piston means. Since this pressure may be sensed in the brake system also to check other situations, there are usually no additional costs involved.

In a preferred embodiment, the spring means is mounted coaxially to the piston of said cylinder/piston means and/or an actuation means mounted intermediate said brake pedal and said piston of said cylinder/piston means. Depending on the design of the brake pedal means, said spring may also be mounted intermediate a fixed location of said brake pedal and said piston of said cylinder/piston means.

In still another embodiment, the spring means is mounted intermediate said piston of said cylinder/piston means and said brake pedal and/or said actuation means mounted intermediate said cylinder/piston means and said brake pedal.

Depending on the way the spring means is attached to the brake pedal, the spring means may excert push and/or pull forces on the brake pedal. Moreover, the spring means may be designed to simulate the behaviour of a conventional brake system when the brake pedal is depressed.

Preferably, the support means for supporting the cylinder of the cylinder/piston means relative to the brake pedal means is rigidly mounted to the cylinder.

In order to allow for a normal actuation and an emergency actuation of the brake system a valve means is mounted intermediate said cylinder/piston means and the brake system of the motor vehicle to separate the chamber of the cylinder/piston means from the brake system during a normal actuation and to connect the chamber of the cylinder/piston means with the brake system for an emergency actuation.

The present invention also relates to an electronically controlled brake system of a motor vehicle having an actuation means as described above, wherein said electronic control unit (ECU) is adapted to bring sensor signals representing a dimension resulting from and characterizing an actuation of the brake pedal into a relation with a speed, acceleration and/or traction signal resulting from the rotational behaviour of the wheels of said motor vehicle.

Further features, characteristics and advantages of the subject matter of the present invention will become appearant to a person skilled in the art when studying the following description of presently preferred embodiment referring to the enclosed drawings wherein

fig. 1 shows a longitudinal sectional view of an actuation means for an electronically controlled brake system of a motor vehicle in a first embodiment,

fig. 2 shows a longitudinal sectional view of an actuation means for an electronically controlled brake system of a motor vehicle in a second embodiment,

fig. 3 shows a longitudinal sectional view of an actuation means for an electronically controlled brake system of a motor vehicle in a third embodiment,

fig. 4 shows a longitudinal sectional view of an actuation means for an electronically controlled brake system of a motor vehicle in a 4th embodiment,

fig. 5 shows a brake pedal means and the support means thereof with a spring means mounted between a fixed location of the brake pedal means and a fixed location of the support means, and

fig. 6 shows another embodiment of a brake pedal means and a the support thereof, where the spring means is mounted between a fixed location of the brake pedal means and a fixed location at the chassis of the motor vehicle.

Referring to fig. 1, an actuation means for an electronically controlled brake system of a motor vehicle comprises a cylinder/piston means 10 formed of a hydraulic cylinder 12 and a hydraulic piston 14 axially movable within said cylinder 12. The piston 14 is biased into its rest position by a helical spring means 16 abutting the bottom 18 of the cylinder 12 and the front face 22 of the piston 14. The piston 14 is provided with a hollow cylindrical tube 24 at the side opposite the front face 22. In this tube 24 one end portion of a pushing rod 26 is slidably mounted. The other end portion of the pushing rod 26 is rotatably connected to a brake pedal 28 by a fulcrum 30. The brake pedal 28 is provided with a stepping plate 32 at the free end thereof and is rotatably supported at the other end of the brake pedal 22 by a supporting pin 34. A first sensor means 36 is coupled to the brake pedal 28 or the pin 34 to sense a rotational movement of the brake pedal 28 about the pin 34 relativ to a support 38 of the brake pedal 28. A spring means 40 is provided coaxially to the actuation rod 26 and the hollow cylindrical tube 24 intermediate the brake pedal 28 and the piston 14 of the cylinder/piston means 10.

A second sensor means 42 is provided in a fluid conduit 44 connceting a hydraulic chamber 46 in the cylinder/piston means 10 with an electromagnetic valve 48. The second sensor means 42 is a pressure sensor adapted for sensing the pressure in the chamber 46 defined by the cylinder 10 and the piston 14 of the cylinder/piston means 10 and/or in the conduit 44.

In a normal actuation position, the movement of the cylinder/piston means 10 against the spring forces of the spring means 40 is sensed by the first sensor means 36 by detecting the rotational movement of the brake pedal 28 relative to the pin 34.

In the normal actuation position, the electromagnetic valve means 48 is in its closed position I. Consequently, the volume of the hydraulic chamber 46 can not be changed by actuating the brake pedal 28. However, the pressure in the hydraulic chamber 46 is increased as the spring means 40 pushes the piston 14 in the direction P upon depression of the brake pedal 28. This

is sensed by the second sensor means 42 sensing the pressure in the chamber 46. At the same time, the rotational angle α of the brake pedal 28 about the pin 34 is sensed with the first sensor means 36. The output signals of the two sensor means 36, 42 are fed into an electronic control unit ECU (not shown). Within the electronic control unit, these two sensor signals are processed and among other operations checked for consistency.

The valve means 48 is an electromagnetic valve having two positions, the first position I where an inlet port 48a of the valve means 48 is separated from an outlet port 5a and a second position II where the inlet port 48a is in fluid connection with the outlet port 48b. Upon energization of an electromagnetic means 48c the electromagnetic valve means 48 is forced into the first position I against the force of a spring means 48d. Upon de-energization of the electromagnetic valve means 48, the spring means 48d forces the valve 48 into the second position II. The first position I where the chamber 46 of the cylinder/piston means 10 is separated from the brake system is the normal actuation position, whereas the second position II is the emergency actuation position, where the hydraulic fluid from the chamber 46 is fed into the brake system via the valve means 48 upon an actuation of the brake pedal 28.

In case of a rupture of the spring means 40, the signal from the first sensor means 36 representing the rotational angle of the brake pedal 28 with respect to the pin 34 is inconsistent with the signal from the second sensor means 42 detecting the pressure in the hydraulic chamber 46.

In this embodiment, the spring means 40 is surrounding the actuation rod 26. Consequently, the cylinder/piston means 10 can be designed as a encapsulated unit independently from the type of motor vehicle in which the actuation means is to be used. The spring means can be selected as desired and mounted in the actuation means without the neccessity of changing the design and construction of the cylinder/piston means 10.

In the subsequent figs. 2 to 6, identical, similar or equivalent parts are denoted with the same reference numerals as in fig. 1.

The main difference between the embodiment of fig. 1 and the embodiment of fig. 2 is the type of sensor used to replace the rotational angle sensor 36 in fig. 1. A sensor adapted for sensing the distances between a predetermined location along the brake pedal 28 and the support means 32, namely a linear detector 54 is provided. A part from that, the structure and mode of operation as well as the advantages obtained thereby are the same as with the embodiment of fig. 1.

The main difference between the embodiment of fig. 2 and the embodiment of fig. 3 is the spring means 40 being mounted within the cylinder/piston means 10. To this end, the piston 14 is comprised of two parts 14a and 14b. The first part 14a is sealing the chamber 46. The second part 14b is rigidly connected with the actuation rod 26 and is held separated from the first part 14a by the spring means 40 in the rest position (shown in fig. 3). In the normal actuation position, the travel path of the brake pedal 28 is sensed with the linear detector 54 between the support 38 and the brake pedal 28. The force acting on the stepping plate 32 is sensed by a force sensor 56 mounted in the stepping plate 32. If a rupture of the spring 40 occurs, the distance measured by the linear detector 54 is inconsistent with the force acting on the stepping plate 32 sensed by the force sensor 56.

While the embodiments of fig. 1 and 2 allow for a relatively short cylinder/piston means 10, the cylinder/piston means 10 of fig. 3 has a larger axial extension since the spring means 40 is also housed within the cylinder 12 of the cylinder/piston means 10.

The main difference between the embodiment of fig. 3 and the embodiment of fig. 4 is the sensing of the movement of the actuation rod 26 or the second part 14b of the piston 14 which are rigidly connected to each other relative to the support means 38 of the brake pedal 28 or the cylinder 12 of the cylinder/piston means 10 which are also rigidly coupled to each other.

Again, in case of a rupture of the spring means 40, the signal provided by the force sensor 56 representing the force acted on the stepping plate 32 is inconsistent with the signal provided by the linear detector 54 representing the relative movement between the actuation rod and the second part of the piston 14b relative to the cylinder 12 or the support means 38.

Fig. 5 shows one solution for the mounting of the force sensor 56 such that the force of actuation excerted by a driver on the stepping plate 32 of the brake pedal 28 can be sensed reliably. The spring means 40 is mounted intermediate the brake pedal 28 and the force sensor 56 which is non-movably fixed to the support means 38. Preferrably, the spring means 40 is held between the brake pedal 28 and the force sensor 56 (or the support means 38, respectively) under pretension. Thus, a rupture of the spring means 40 can be sensed due to the non-existence of a signal from the force sensor 56 in the electronic control unit ECU (not shown). The cylinder/piston means 10 and the valve means 48 (not shown in fig. 5) may be the same as for example in fig. 3.

It is also possible to have the force sensor means 56 mounted intermediate the piston 14 and the spring means 40 surrounding the actuation rod 26. Moreover, the spring means 40 may be more than one spring element or several spring elements mounted at different locations in the actuation means.

Fig. 6 shows a further solution to the mounting of the force sensor 56 and the spring means 40. The main difference between the embodiment of fig. 6 and fig. 5 is the spring means 40 operating as a pull spring means, whereas in fig. 5, the spring means 40 is acting as a push spring means. In fig. 6, one end portion of the spring means 40 is coupled to the brake pedal 28 between the fulcrum 30 and the supporting pin 34. The

other end portion of the spring means 40 is connected to a force sensor assembly 60 rigidly connected to the chassis of the motor vehicle by a bolt 62. The spring means 40 is held between the force sensor assembly 60 and the brake pedal 28 under pretension. Again, the cylinder/piston means 10 and the electromagnetic valve means 48 shown in figs. 3 or 1 can be combined with the brake pedal assembly shown in fig. 6.

Moreover, the spring means 40 can have a non-linear, preferrably progressive, spring characteristic in order to give the driver the same or similar pedal feeling as with an conventional brake system during a normal actuation. An inconsistency between the signal derived from the force sensor 56 and a sensor signal from another sensor means provided in the actuation means can be detected by an electronic control unit ECU and indicates the failure of a component in the actuation means.

Claims

1. Actuation means for an electronically controlled brake system of a motor vehicle, comprising

   - a cylinder/piston means (10) operatively connected to a brake pedal (28) to feed hydraulic fluid into a brake system of the motor vehicle,
   - a spring means (40) resiliently biasing the brake pedal (28) against an actuation direction P of the brake pedal (28), characterized by
   - at least two sensor means (36, 42, 54, 56) for sensing dimensions related to a normal actuation of the brake pedal (28), said at least two sensor means (36, 42, 54, 56) being adapted to output sensor signals to an electronic control unit (ECU) for processing said sensed dimensions.

2. Actuation means for an electronically controlled brake system according to claim 1, characterized in that

   - one of said sensor means (36) is adapted for sensing a rotational angle (α) resulting from a rotational movement of the brake pedal (28) about a support means (38) of said brake pedal (28).

3. Actuation means for an electronically controlled brake system according to claim 1 characterized in that

   - one of said sensor means (54) is adapted for sensing the distance (S) between a predetermined location of said brake pedal (28) and a location being in a fixed relation to a support means (38) of said brake pedal (28).

4. Actuation means for an electronically controlled brake system according to claim 1, characterized in that

   - one of said sensor means (54) is adapted for sensing the distance (S) resulting from a movement of the piston (14) relative to the cylinder (12) of said cylinder/piston means (10).

5. Actuation means for an electronically controlled brake system according to claim 1, characterized in that

   - one of said sensor means (56) is adapted for sensing a force (F) representative for an actuation force acting on said brake pedal (28).

6. Actuation means for an electronically controlled brake system according to claim 1, characterized in that

   - one of said sensor means (42) is adapted for sensing a pressure (P) representative for a pressure in a chamber (46) of the cylinder/piston means (10).

7. Actuation means for an electronically controlled brake system according to any of claims 1 to 6, characterized in that

   - said spring means (40) is mounted coaxially to the piston (14) of said cylinder/piston means (10) and/or an actuation means (26) mounted intermediate said brake pedal (28) and said piston (14) of said cylinder/piston means (10).

8. Actuation means for an electronically controlled brake system according to any of claims 1 to 7, characterized in that

   - said spring means (40) is mounted intermediate a fixed location of said brake pedal and said piston of said cylinder/piston means (10).

9. Actuation means for an electronically controlled brake system according to any of claims 1 to 7, characterized in that

   - said spring means (40) being mounted intermediate said piston (14) of said cylinder/piston means (10) and said brake pedal (28) and/or said actuation means (26) mounted intermediate said cylinder/piston means (10) and said brake pedal (28).

10. Actuation means for an electronically controlled brake system according to any of claims 1 to 9, characterized in that

    - said spring means (40) is adapted to excert

push and/or pull forces on said brake pedal (28).

11. Actuation means for an electronically controlled brake system according to any of claims 1 to 10, characterized in that a support means (38) for supporting said cylinder (12) of the cylinder/piston means (10) is rigidly coupled to said cylinder (12).

12. Actuation means for an electronically controlled brake system according to any of claims 1 to 11, characterized in that

- a valve means (48) is mounted intermediate said cylinder/piston means (10) and the brake system of the motor vehicle to separate the chamber (46) of the cylinder/piston means (10) from the brake system during a normal actuation and to connect the chamber (46) of the cylinder/piston means (10) with the brake system for an emergency actuation.

13. Electronically controlled brake system of a motor vehicle comprising an actuation means of any of claims 1 to 12, characterized in that

- said electronic control unit (ECU) is adapted to put sensor signals representing a dimension resulting from an actuation of the brake pedal (28) into a relation with a speed, acceleration and/or traction signal resulting from the rotational behaviour of the wheels of said motor vehicle.

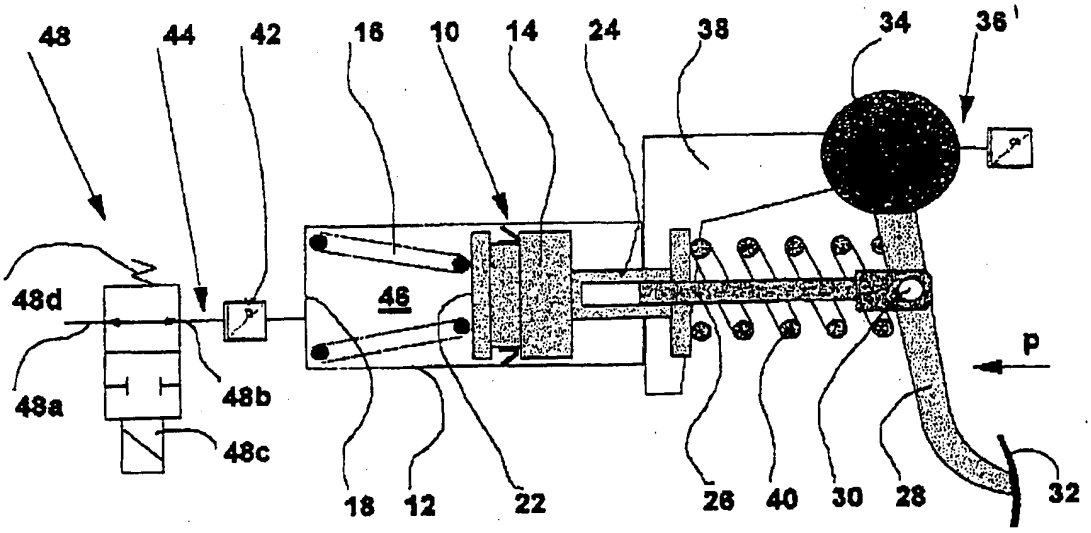
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Fig. 1

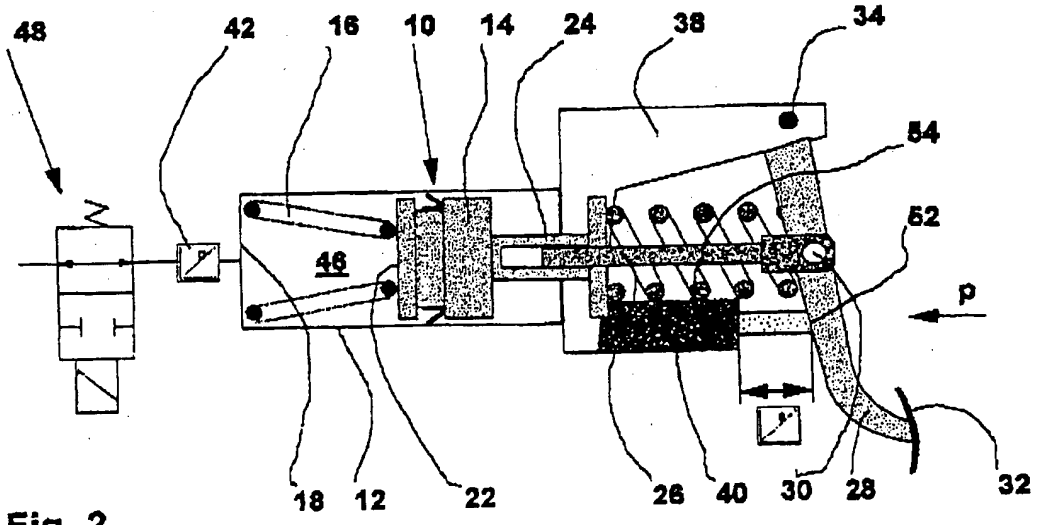
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Fig. 2

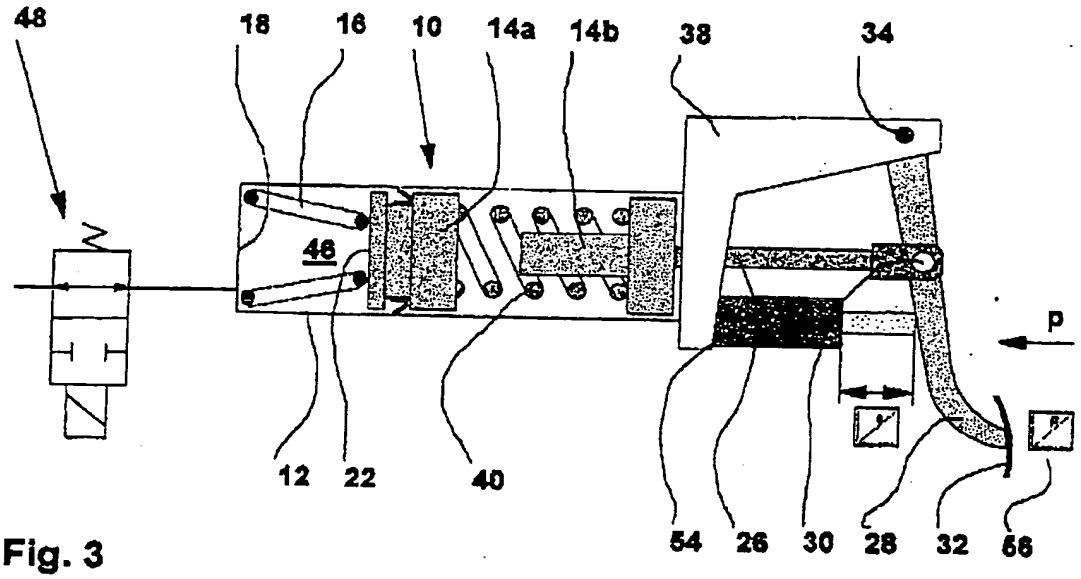
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Fig. 3

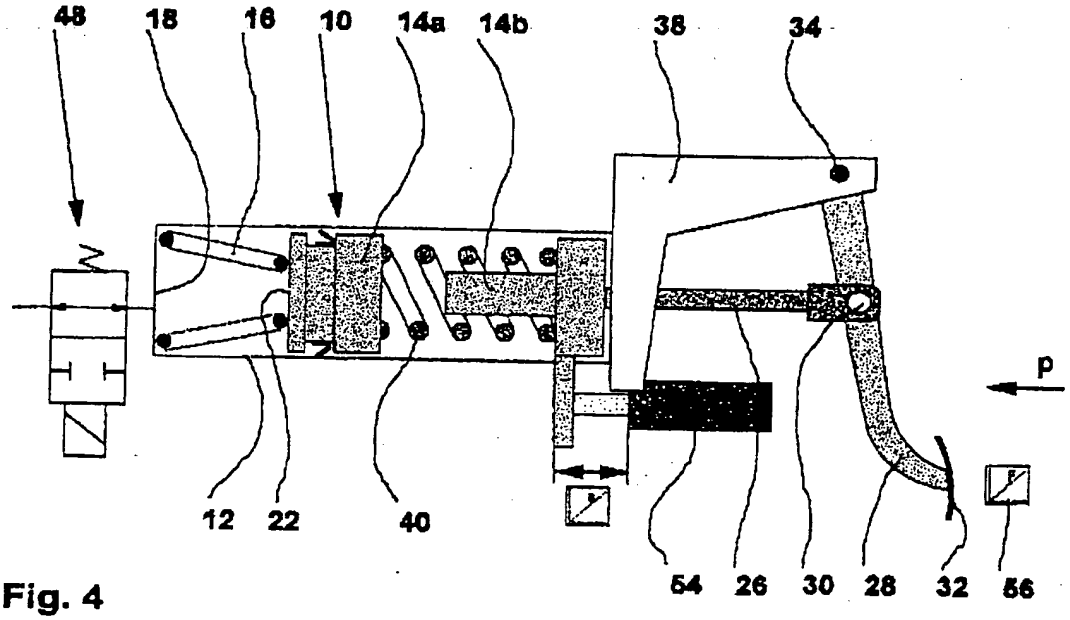
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Fig. 4

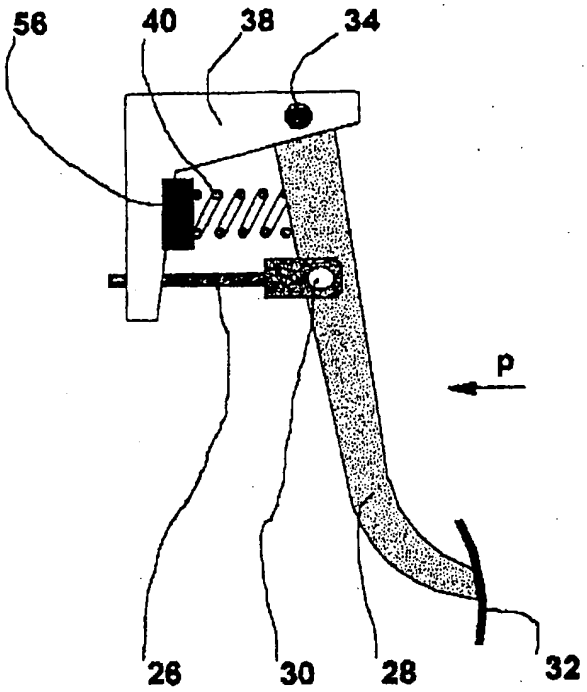

Fig. 5

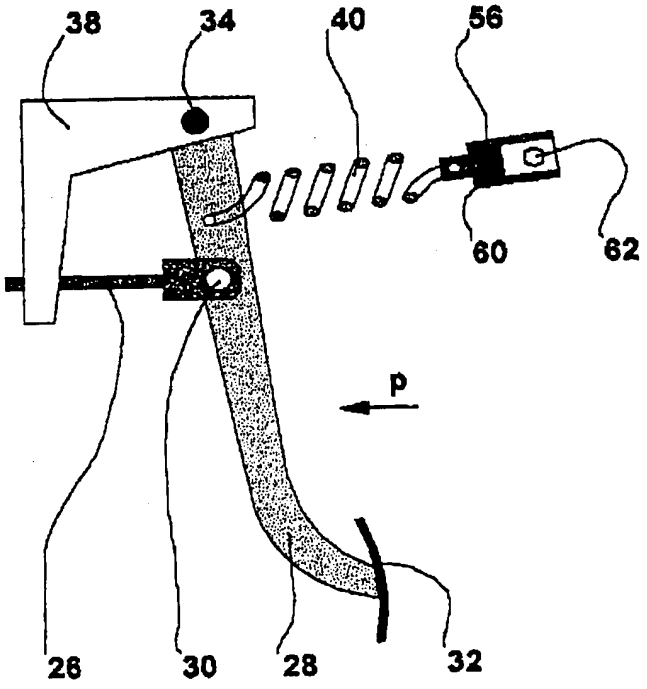

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 7220

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE-A-43 43 314 (ROBERT BOSCH) * column 3, line 14 - column 5, line 61; figures 1,2 *	1,2,6, 10-13	B60T17/22 B60T7/04 B60T13/66 B60T8/32
X	DE-A-43 43 386 (ROBERT BOSCH) * column 4, line 30 - column 5, line 41; figures *	1,3,4,6, 7,10-12	
X	PATENT ABSTRACTS OF JAPAN vol. 16 no. 585 (M-1347) ,25 December 1992 & JP-A-04 232154 (TOYOTA MOTOR CORP.) 20 August 1992, * abstract; figures 1,2 *	1,3,5, 10-13	
X	GB-A-2 128 279 (ROBERT BOSCH) * page 1, line 3 - line 15 * * page 2, line 6 - line 53; figure 1 *	1,3,7,8, 10,11	
X	DE-A-22 49 007 (TELDIX) * page 5, last paragraph - page 7, paragraph 2; figure 1 *	1,3,6,7, 9-11,13	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B60T
X	DE-A-23 27 508 (TELDIX) * the whole document *	1,7,9-11	
X	DE-C-41 02 497 (MERCEDES-BENZ) * column 12, line 12 - column 13, line 3 * * column 15, line 58 - column 16, line 12; figures 1,4 *	1-4,6,7, 10-13	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 February 1996	Meijs, P

CATEGORY OF CITED DOCUMENTS

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X	US-A-5 312 172 (TAKEUCHI) * column 3, line 49 - line 57 * * column 5, line 10 - line 14; figure 1 * ---	1,5-7, 10-13	
A	US-A-4 812 777 (SHIRAI) * column 11, line 4 - line 8; figure 1 * ---	3-5,7, 10-13	
A	FR-A-2 318 060 (ROBERT BOSCH) * page 9, line 18 - line 27; figure 4 * -----	8	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)

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